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• Timber Frame Withstands Fire

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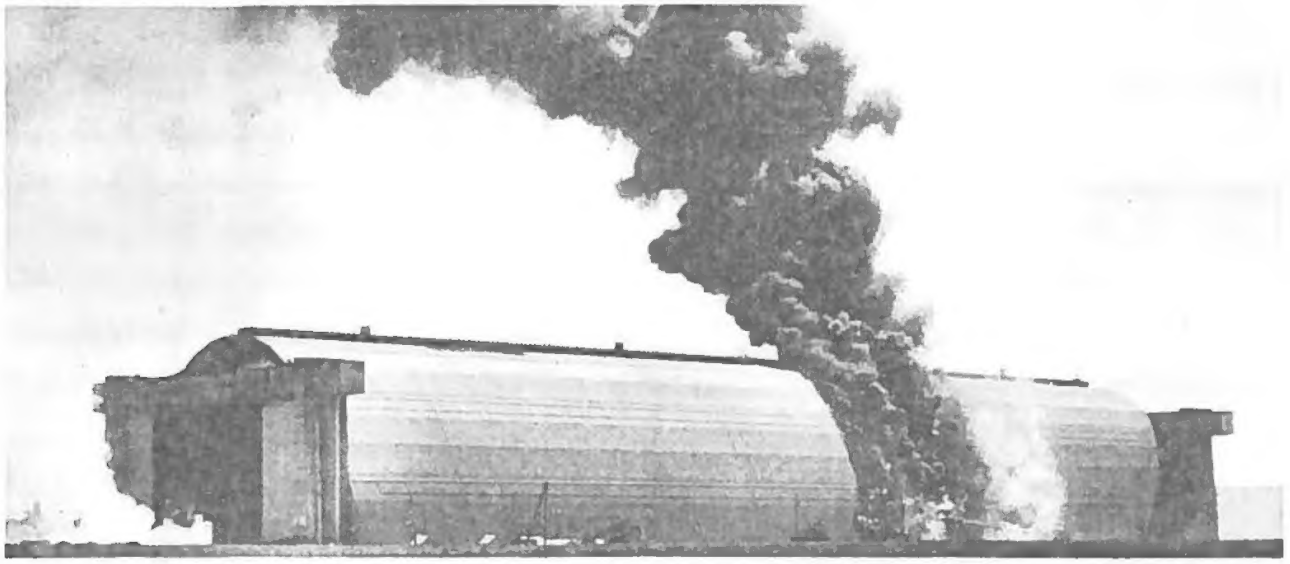
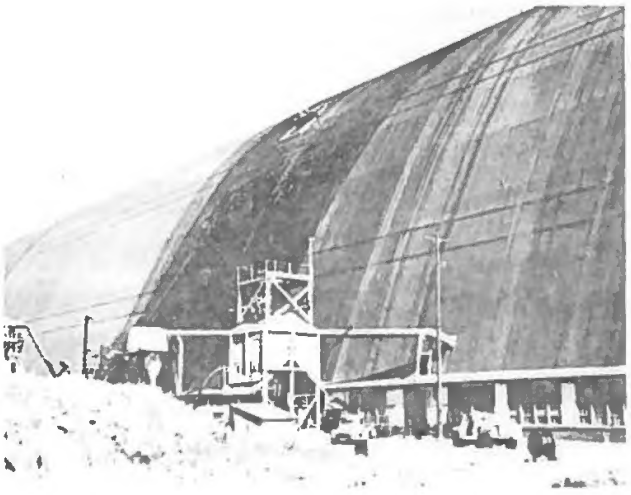


Fire . . .

Roofing material burned when residuals in plywood manufacturing facilities, now occupying former World War II blimp hangar at Tillamook, Ore., burst into flames



But Timber Hangar Frame Stands Up

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Although a fire late last summer burned 40,000 sq ft of roofing from a large blimp hangar, no damage was suffered by the structural timber framing—a fact that naturally interested the West Coast Lumbermen's Association, which has just completed a detailed study of the structure.

The structure was one of a number of blimp hangars built by the Navy during World War II along the Atlantic, Pacific, and Gulf coasts (ENR Oct. 23, 1942, p. 110), which are claimed to be the largest timber framed buildings in the world. It is located 80 mi west of Portland, Ore., at Tillamook.

The building consists of an arched roof shell, stiffened with a series of transverse arch ribs. It is 1,000 ft long, 170 ft high at the crown and has an overall width at the ground of about 296 ft.

• **Design details**—The arch ribs are truss type, spaced on 20-ft centers, and supported on reinforced concrete abutment bents 24 ft in height. The trussed ribs are 18½ ft deep. Chords vary from two 3x12 to two 4x12 pieces and the web verticals from one 4x8 to one 6x18 piece while the web diagonals consist of two 3x8's.

Purlin trusses, 12 ft c to c, have a 3x10 top chord. The rafters are 3x12's, at about 7 ft spacing, and the roof is sheathed with 2-in. tongue-and-groove planking.

The sheathing constitutes the main bracing for the top chord of the arch ribs, but this is supplemented by V-bracing in the lower part of the building height. In the plane of the bottom chord of the arch ribs, cross-bracing is placed in every other bay. Both split-ring and shear-plate timber connectors were used profusely in the joining of members.

A catwalk runs the length of each side of the hangar at a height above ground of 137 ft. There are stairways at each end of the hangar from the ground to the catwalks and thence to the roof, and a stairway at the middle leading to the catwalks only. A monitor runs the full length of the ridge of the building.

All of these wood parts were pressure impregnated with chemicals for high fire retardance. Federal specifications under which the salts were manufactured and applied are similar to those in use today (MIL-C-2865 and MIL-C-2799). Due to the large

volume of lumber needed in the wartime rush to complete these many hangars, about fifty treating facilities were used in applying the fire-retardant salts. Hence, in the Tillamook hangars, both Minalith and Protexol were used.

There is another bit of wood framing in a runway inside of the monitor at the top of the building that was not treated with fire retardants. Apparently this was put in after the hangars were built, as it is not shown on the original plans.

• **Roofing**—A description of the roof covering is important as this is the part of the building most involved in the fire. The original roofing was of two types. On the side slopes nearly up to the top, roll roofing in 36-in. widths was laid horizontally with each strip overlapping the lower one, shingle fashion, by 19 in. The 17-in. portion of the roofing exposed to the weather was mineral surfaced.

For most of this roofing the lap of the roll roofing was cemented to the undercourse. Higher up the lap was mopped with hot asphalt to the undercourse and galvanized roofing nails secured this portion of the roof covering to the sheathing. On the flatter portion of the roof, a built-up covering was used consisting of four plies of asphalted felt with each ply mopped with hot asphalt. Of recent date, a new roof of mineralized-surface, asphalted felt shingles, was placed over the original roof covering.

• **Hangar converted to wood plant**—After the war, the Navy leased the airport and the two hangars to Tillamook County, which, in turn, has subleased the buildings. The hangar was occupied by a lumber and plywood operation, with the contents consisting of machinery for remanufacturing lumber—saws, planers and the like. This installation also included a plywood plant having a veneer lathe, veneer dryer, glue press and other necessary machinery. And stocks of lumber and plywood were in the building.

Veneer dryers, using relatively high temperatures are a potential source of fire in plywood plants. Hence, automatic deluge-type sprinklers are built into the equipment. The moisture and residue from the dryers is vented through a duct to outside atmosphere. For these particular kilns, the vent ducts had to be run horizontally and through the side of the building—a vertical vent being impractical due to the great height of the structure. As the horizontal run of the ducts reduced natural draft, an exhaust fan was installed in the duct 10 ft to 12 ft inside the wall of the building.

The fire started on the residues deposited in the short portion of one of the ducts between the exhaust fan and the end of the duct at the outside of the building. Since there was no pilot sprinkler head at the end of the duct, the fire burned freely until noticed. Then a manual release on the sprinkler system was operated, but by this time, a strong wind, blowing toward the hangar, had directed the torch-like flame from the duct against the side of the building and ignited the roof covering.

Fire fighting began with hoses attached to outside hydrants, later supplemented by fire department pumpers. However, the height of the building would only permit an attack at the base of the fire with the hydrant pressure. Before long the fire had swept straight up the side of the building and had spread downward. It fed on the untreated catwalk on top of the monitor and on sawdust and shavings, which had been windswept to the top and packed under the catwalk. Fire also attacked dust and debris in the valley made by the intersection of the monitor and roof.

Men working with hydrant hoses and pumper streams from the ground and from the top of two platforms supporting dust-collector bins just outside the hangar, beat down the fire on the lower part of the roof. But they were only able to reach about one-third of the height with their hose streams. Another crew was on the inside trying to reach the underside of the roof with pumper streams, but because of the height could only get brief spurts of water up to the top part of the inside fire area.

When pressures were raised to reach higher, the men could not hold the hoses, and none of the local equipment included any form of turret nozzle. But after about an hour, hose lines reached crews on the roof and the blaze was controlled.

In the meantime, the fire had charred through the treated 2-in. roof decking at about mid-height of the building. This was the area most difficult to reach with hose streams. The opening acted like a flue so that a portion of the flame from the burning roof billowed inside the hangar and was exhausted along the monitor. This flame on the inside probably ignited the runway in the monitor, which was slowly destroyed along its length. It is known that this runway was not pressure treated with fire-retardant chemicals, but it has been reported as having been brush treated with fire-retardant paint. If so, the effectiveness of this coating probably had deteriorated in the moist, coastal climate of Tillamook County.

Even after the major roofing blaze was knocked down, there remained slow, slippery work on the sloping sides of the building, using safety ropes and hose, to put out the smoldering fires between the layers of the roofing. The fire was dead out seven hours after it started.

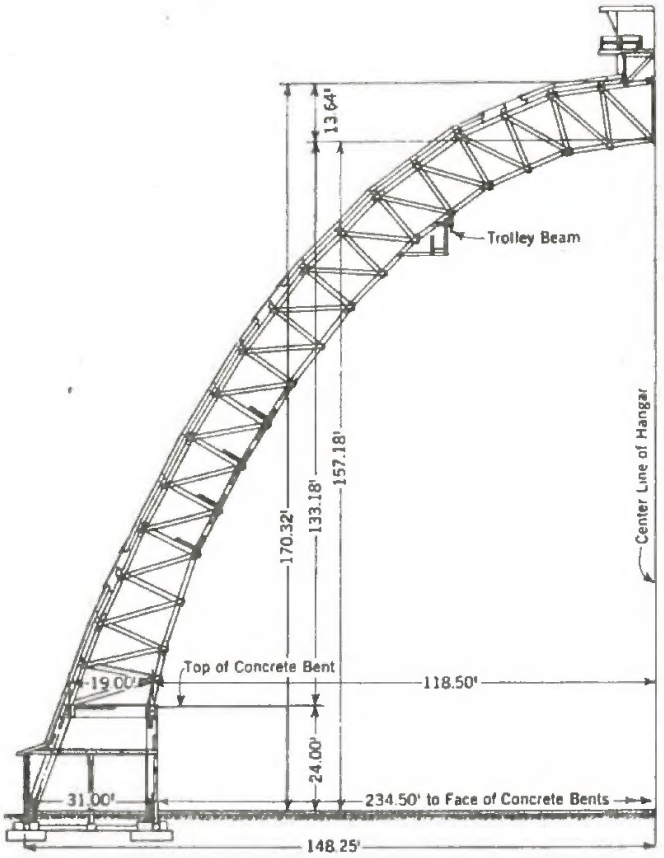
• **Lessons learned**—A study of the fire damage shows the effectiveness of fire-retardant treated lumber. The treated, wood roof deck proved to be a good fire barrier, even though about 3,000 sq ft of the 2-in. planking was charred through. This, plus char of varying depth, required the replacement of 15,000 sq ft of the 2-in. plank deck. And 1,500 sq ft of ½-in. plywood was used to restore the thickness in less charred areas. A small amount of 2x6 material was nailed to the sides of the top of some rafters for a nailing surface for replacement of the plank deck. Other replacements included the runway in the monitor, two of four hose houses, 400 squares of roofing, and the 2-in. pipe handrail along the top, which was bent and twisted from heat.

No other repairs were required, since no structural damage occurred in rafters, purlins, bracing and other parts despite the fact that flames swept through the charred hole in the roof.

More than 10 years ago, a group of these hangars was subjected to fire after collapse due to hurricane. This happened on Sept. 15, 1945, at the Naval Air Station, Richmond, Fla. Aircraft and automobiles parked in these hangars at the time were consumed by fire fed by fuel from their tanks. The reports of that collapse and resulting fire show that the fire-retardant treated lumber was consumed in the area exposed to the flame of other burning materials. But it did not spread into the tumbled mass of collapsed, treated wood beyond those areas.

As the Richmond structures were a total loss from hurricane damage, even before the fire started, no conclusions were reached regarding the structural protection afforded by the fire-retardant treatment. Both of these fires support the fact that lumber pressure-treated with fire-retardant chemicals will not maintain its own combustion, and that it will resist the spread of fire. Like untreated, heavy timber framing, it can be consumed only by a severe-exposure fire of long duration.

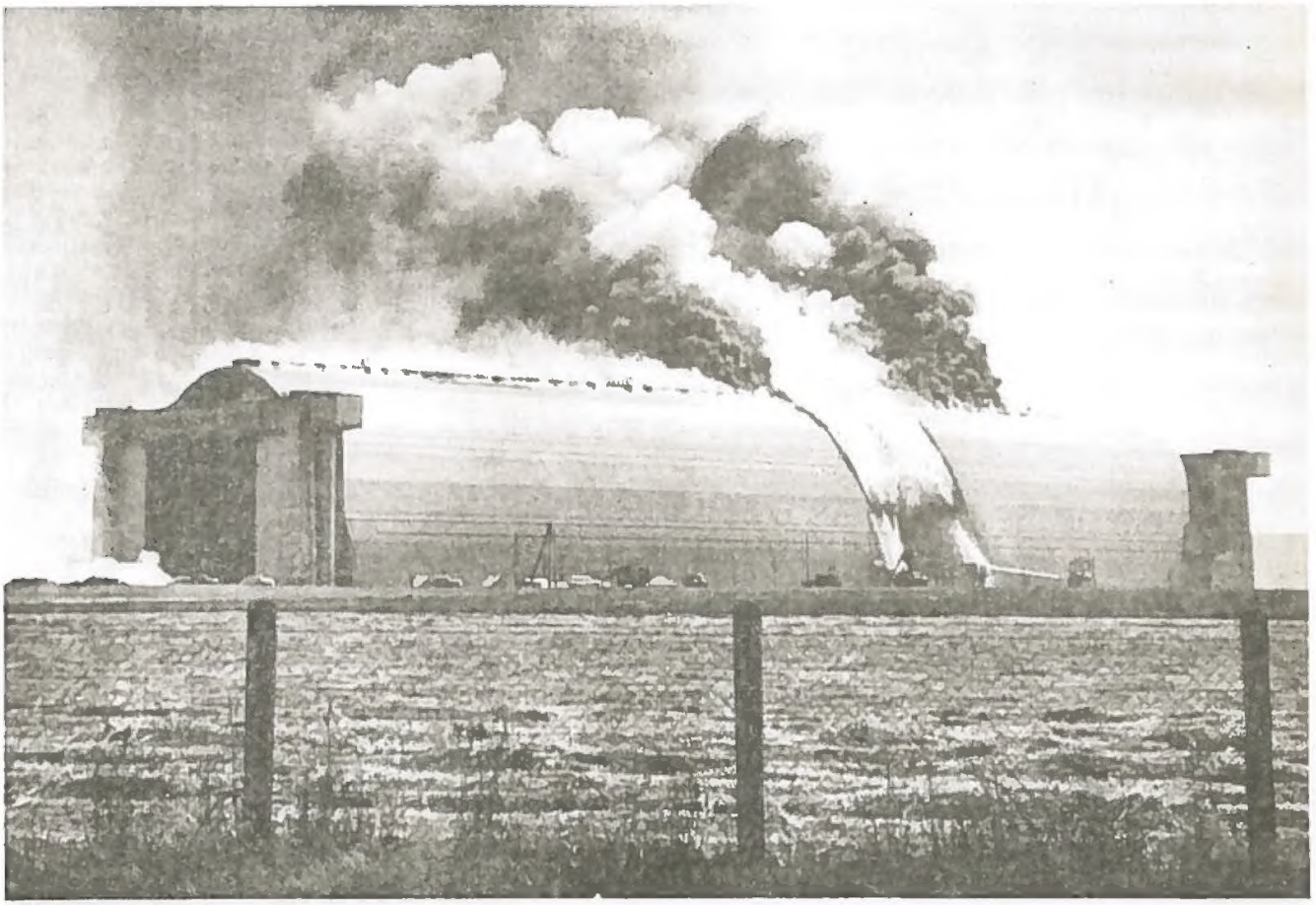
This suggests that the 1949 edition of the National Building Code, promulgated by the National Board of Fire Underwriters is conservative in recommending an allowable increase of 33⅓% in the areas of one-story buildings of heavy timber construction, ordinary construction, and wood-



TYPICAL SECTION OF HANGAR

frame construction, when all the wood parts are of approved fire-retardant treated lumber. In some sections of the country, insurance-rating bureaus use schedules allowing credits in fire-insurance rates when fire-retardant treatments are used. Even so, it now appears that the practice should be more universal and that a review of existing conservative, insurance credits may be in order.

On-site investigations were made by F. L. Mattson, manager, insurance department, West Coast Lumbermen's Assn., and D. F. Kinder, consultant to Timber Structures, Inc., and acknowledgement is made to their assistance. J. J. Johnson, manager of the property at Tillamook, has been at the station since its early days, and aided in directing the volunteer fire fighters. His account of the fire and knowledge of the construction was very valuable in preparing the reports used herein. The original plans and specifications, used by Timber Structures, Inc., in fabrication of the structural framing of the Tillamook hangars, were used for the detailed information about the structure.



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